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Escitalopram oxalate: co-existence of  
oxalate dianions and oxalic acid  
molecules in the same crystalWilliam T. A. Harrison,<sup>a\*</sup> H. S. Yathirajan,<sup>b</sup> S. Bindya,<sup>b</sup>  
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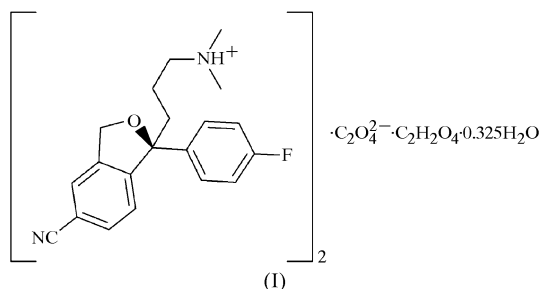
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The title compound {systematic name: (+)-(*S*)-3-[5-cyano-2-(4-fluorophenyl)-1,3-dihydroisobenzofuran-2yl]propanaminium oxalate oxalic acid 0.325-hydrate},  $2\text{C}_{20}\text{H}_{22}\text{FN}_2\text{O}^+ \cdot \text{C}_2\text{O}_4^{2-} \cdot \text{C}_2\text{H}_2\text{O}_4 \cdot 0.325\text{H}_2\text{O}$ , is a molecular salt of the N-protonated escitalopram cation. As well as charge-balancing oxalate dianions, neutral molecules of oxalic acid are present. The component species interact by way of  $\text{N}-\text{H} \cdots \text{O}$  and short

$\text{O}-\text{H} \cdots \text{O}$  hydrogen bonds, resulting in supramolecular chains.

## Comment

(+)-(*S*)-1-[3-(Dimethylammonio)propyl]-1-(4-fluorophenyl)-5-phthalan-5-carbonitrile oxalate ( $\text{C}_{20}\text{H}_{21}\text{FN}_2\text{O}$ ), common names escitalopram or *S*-(+)-citalopram, is a widely prescribed drug used to treat depression and related conditions (Burke, 2002). It is conveniently introduced as an oxalate salt, with a nominal formula usually given as  $\text{C}_{20}\text{H}_{21}\text{FN}_2\text{O} \cdot \text{C}_2\text{H}_2\text{O}_4$ , *i.e.* the presumed proton-transfer reaction is not specified (Sorbera *et al.*, 2001). As part of our ongoing crystallographic studies of pharmaceutical molecules (Harrison *et al.*, 2005), we now report the structure of the title compound, (I), in which two N-protonated escitalopram cations ( $\text{C}_{20}\text{H}_{22}\text{FN}_2\text{O}^+$ ) and a  $\text{C}_2\text{O}_4^{2-}$  oxalate dianion are accompanied by a neutral molecule of oxalic acid and a partially occupied water molecule (Fig. 1).



The bond lengths and angles in (I) fall within their expected ranges (Cambridge Structural Database, Version 5.27; Allen,

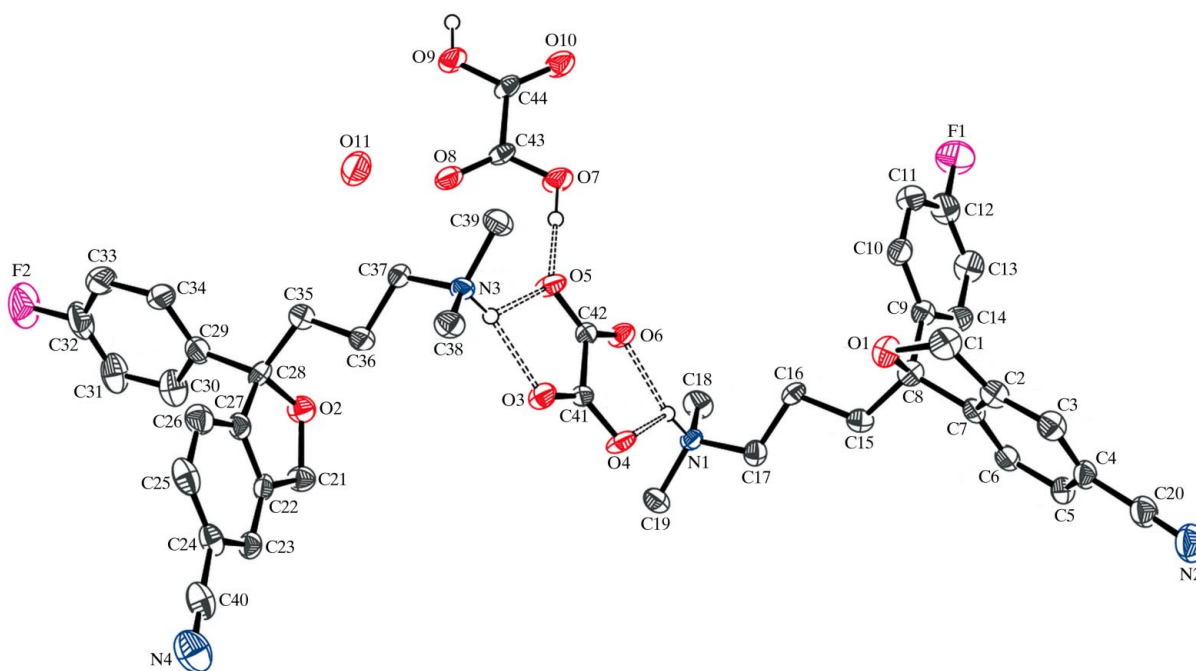


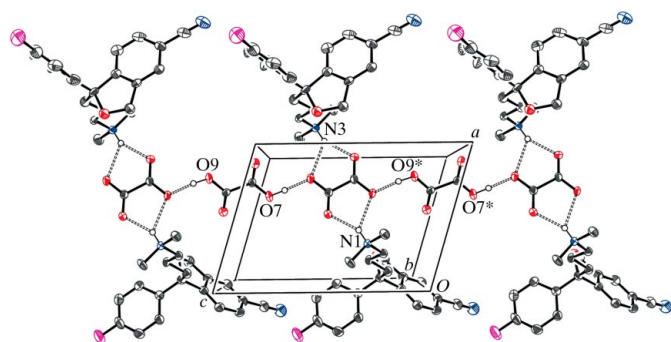
Figure 1

The molecular structure of (I), showing 50% probability displacement ellipsoids (arbitrary spheres for H atoms). All H atoms, except those involved in hydrogen bonds (dashed lines), have been omitted for clarity.

2002). There are two  $C_{20}H_{22}FN_2O^+$  cations in the asymmetric unit; atoms C8 and C28 are assumed to possess *S* configurations, consistent with the known absolute structure of the biologically active enantiomer of citalopram (Sanchez *et al.*, 2004). For the C1-containing molecule, the dihedral angle between the mean planes of the C2–C7 and C9–C14 benzene rings is  $62.83(13)^\circ$ , and the C1/C2/C7/C8/O1 five-membered ring displays an envelope conformation with atom O1 in the flap position [the displacement from the C-atom mean plane is  $0.435(5) \text{ \AA}$ ]. In the C21-containing molecule, the dihedral angle between the C22–C27 and C29–C34 mean planes is  $81.99(13)^\circ$ , and the envelope conformation for C21/C22/C27/C28/O2 is less pronounced, with atom O2 displaced from the C-atom mean plane by  $0.113(6) \text{ \AA}$ . The oxalate species are both approximately planar; the dihedral angle between the C41/O3/O4 and C42/O5/O6 groupings is  $4.4(3)^\circ$ , and the equivalent value for C43/O7/O8 and C44/O9/O10 is  $2.8(6)^\circ$ .

The component species in (I) interact by way of  $N-H \cdots O$  and  $O-H \cdots O$  hydrogen bonds (Table 1), such that both  $C_{20}H_{22}FN_2O^+$  cations make bifurcated  $N-H \cdots (O,O)$  hydrogen bonds to the same oxalate dianion. Then, the  $2C_{20}H_{22}FN_2O^+ \cdot C_2O_4^{2-}$  units are linked into [001] chains by way of the oxalic acid molecules, *i.e.* the oxalate dianions and oxalic acid molecules alternate in the chains (Fig. 2). The short  $H \cdots O$  separations of the oxalic acid-to-oxalate hydrogen bonds suggests that they are strong interactions.

Although it is not expected from a consideration of the  $pK_a$  values of oxalic acid ( $pK_{a1} = 1.23$  and  $pK_{a2} = 4.19$ ; Newkome *et al.*, 1985) the co-existence of oxalate dianions and oxalic acid molecules in the same crystal has been observed in a number of compounds, three examples being bis(pyridinium) oxalate oxalic acid (Newkome *et al.*, 1985), barium oxalate oxalic acid dihydrate (Chaix-Pluchery *et al.*, 1989) and 1-( $\alpha$ -pyrrolidiniobenzyl)-2-naphthol oxalate oxalic acid (Periasamy *et al.*, 2004). These three compounds show the same alternating oxalate–oxalic acid hydrogen-bonded chains seen in (I).



**Figure 2**

A view along [010] of part of an [001] chain in (I), with hydrogen bonds shown as dashed lines. Atoms labelled with an asterisk (\*) are generated by the symmetry operation ( $x, y, z - 1$ ).

## Experimental

The title compound was obtained as a gift sample from Jubilant Organosys, Nanjangud, India. The sample of (I) was recrystallized from ethanol (m.p. 420 K).

### Crystal data

$2C_{20}H_{22}FN_2O^+ \cdot C_2O_4^{2-} \cdot C_2H_2O_4 \cdot 0.325H_2O$	$V = 2094.54(14) \text{ \AA}^3$
$M_r = 834.05$	$Z = 2$
Monoclinic, $P2_1$	$D_x = 1.324 \text{ Mg m}^{-3}$
$a = 7.9355(3) \text{ \AA}$	Mo $K\alpha$ radiation
$b = 24.7376(9) \text{ \AA}$	$\mu = 0.10 \text{ mm}^{-1}$
$c = 11.1332(5) \text{ \AA}$	$T = 120(2) \text{ K}$
$\beta = 106.589(2)^\circ$	Block, colourless
	$0.32 \times 0.24 \times 0.18 \text{ mm}$

### Data collection

Nonius KappaCCD diffractometer	7581 measured reflections
$\omega$ and $\varphi$ scans	3609 independent reflections
Absorption correction: multi-scan (SADABS; Bruker, 2003)	2652 reflections with $I > 2\sigma(I)$
$T_{\min} = 0.969$ , $T_{\max} = 0.982$	$R_{\text{int}} = 0.037$
	$\theta_{\max} = 25.5^\circ$

### Refinement

Refinement on $F^2$	$w = 1/[\sigma^2(F_o^2) + (0.0473P)^2]$
$R[F^2 > 2\sigma(F^2)] = 0.042$	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.095$	$(\Delta/\sigma)_{\max} = 0.008$
$S = 1.02$	$\Delta\rho_{\max} = 0.17 \text{ e \AA}^{-3}$
3609 reflections	$\Delta\rho_{\min} = -0.21 \text{ e \AA}^{-3}$
562 parameters	Extinction correction: SHELXL97
H atoms treated by a mixture of independent and constrained refinement	Extinction coefficient: 0.0118 (16)

**Table 1**

Hydrogen-bond geometry ( $\text{\AA}$ ,  $^\circ$ ).

$D-H \cdots A$	$D-H$	$H \cdots A$	$D \cdots A$	$D-H \cdots A$
N1–H1 $\cdots$ O6	0.93	1.91	2.768 (4)	152
N1–H1 $\cdots$ O4	0.93	2.22	2.886 (4)	128
N3–H2 $\cdots$ O3	0.93	1.91	2.764 (4)	152
N3–H2 $\cdots$ O5	0.93	2.22	2.884 (4)	127
O7–H3 $\cdots$ O5	0.91 (3)	1.56 (3)	2.466 (4)	177 (4)
O9–H4 $\cdots$ O4 <sup>i</sup>	0.91 (3)	1.57 (3)	2.465 (4)	173 (4)

Symmetry code: (i)  $x, y, z + 1$ .

Anomalous dispersion effects were negligible and Friedel pairs were merged before refinement. The absolute structure of (I) was assigned on the basis of the known chirality of escitalopram (Sanchez *et al.*, 2004). The C- and N-bound H atoms were placed in idealized locations ( $C-H = 0.95\text{--}0.99 \text{ \AA}$  and  $N-H = 0.93 \text{ \AA}$ ) and refined as riding with  $U_{\text{iso}}(H)$  values of  $1.2U_{\text{eq}}(\text{carrier})$  or  $1.5U_{\text{eq}}(\text{methyl C})$ . The oxalic acid H atoms were located in a difference map and refined with the restraint  $O-H = 0.90(1) \text{ \AA}$  and the constraint  $U_{\text{iso}}(H) = 1.2U_{\text{eq}}(O)$ . The H atoms of the partially occupied water molecule could not be located.

Data collection: COLLECT (Nonius, 1998); cell refinement: SCALEPACK (Otwinowski & Minor, 1997); data reduction: SCALEPACK and DENZO (Otwinowski & Minor, 1997), and SORTAV (Blessing, 1995); program(s) used to solve structure: SHELXS97 (Sheldrick, 1997); program(s) used to refine structure: SHELXL97 (Sheldrick, 1997); molecular graphics: ORTEP-3 (Farrugia, 1997); software used to prepare material for publication: SHELXL97.

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Supplementary data for this paper are available from the IUCr electronic archives (Reference: GD3075). Services for accessing these data are described at the back of the journal.

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